Intraoperative superficial femoral artery balloon angioplasty and popliteal to distal bypass graft: An option for combined open and endovascular treatment of diabetic gangrene

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Purpose: **The purpose of this study was to evaluate the results of combining intraoperative balloon angioplasty (IBA) of the superficial femoral artery (SFA) with distal bypass graft originating from the popliteal artery as a method of lower extremity revascularization in diabetic patients with gangrene.**

Methods: **Among 380 infrainguinal bypass grafts performed over a 6-year period, there were 110 reversed saphenous vein bypass grafts to the tibial or pedal arteries to treat diabetic patients with gangrene. Diffuse infrainguinal disease was treated with femoral-distal bypass graft (long; n = 46). Popliteal-distal bypass graft was performed when the inflow femoral artery was not significantly diseased (short; n = 52). Focal SFA stenosis and severe infrageniculate disease were treated with combined IBA of the SFA and distal bypass graft originating from the popliteal artery (combined; n = 12). Follow-up was performed with duplex scan surveillance of both the bypass graft and IBA sites. Treatment groups were compared with life-table analysis.**

Results: **There were no perioperative graft failures or amputations. The perioperative mortality rate was 1% (1 of 110). The 2-year primary patency rates were similar in the three groups: 72% in the long bypass graft group, 82% in the short bypass graft group, and 76% in the combined group (*P* = .8, log-rank test). SFA IBA sites developed recurrent stenosis in two patients, at 7 and 48 months; both were detected with surveillance and treated with percutaneous transluminal balloon angioplasty. The overall 5-year rate of primary patency was 63%, secondary patency was 78%, limb salvage was 81%, and survival was 35%. There were no significant differences among the three treatment groups with respect to these outcomes.**

Conclusion: **Results with the combined procedure were similar to those achieved with either femoral-distal bypass graft or popliteal-distal bypass graft without SFA IBA. These data suggest that IBA of the inflow SFA may be combined with popliteal to distal bypass graft and that this technique is a reasonable alternative to longer, femoral-origin bypass graft in selected diabetic patients with gangrene. (J Vasc Surg 2001;33:955-62.)**

Infrainguinal vein bypass graft has assumed a prominent role in the prevention of limb loss due to gangrene in diabetic patients. This patient group is characterized by poor long-term survival, severe medical comorbidities, and diseased infrageniculate runoff vessels that prompt the use of small-caliber, distal target sites when revascularization can be performed. These factors suggest that the shortest, simplest bypass graft that provides adequate foot perfusion should be performed. When a tibial or pedal bypass graft is required, it may originate from the femoral arteries in the groin, or if the femoral inflow vessels are free of disease, a popliteal origin bypass graft is a reasonable option.[1,2]

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There is a subset of patients who would be candidates for bypass grafts originating from the popliteal artery except for the presence of focal superficial femoral artery (SFA) stenosis. This pattern of occlusive disease is typically managed by performing a longer bypass graft, with the graft extended proximally to exclude the SFA disease.[3-5] Another option is to combine endovascular and open techniques by performing intraoperative balloon angioplasty (IBA) of the focal SFA stenosis and a distal bypass graft originating from the popliteal artery.

Although SFA balloon angioplasty has not been widely successful as a sole procedure for diabetic limb salvage, combining it with distal bypass graft provides some advantages.[6-8] The combined procedure permits a shorter bypass graft to be performed when vein length is inadequate, decreases the magnitude of the operation in high-risk patients, and avoids parallel incisions at the ankle, which are often required for a femoral-pedal bypass graft. If recurrent SFA stenosis develops later, it may be treated electively, with either percutaneous transluminal balloon angioplasty (PTA) or above-knee femoral-popliteal bypass graft.

The purpose of this study was to assess whether combined IBA of the SFA and popliteal to distal bypass graft

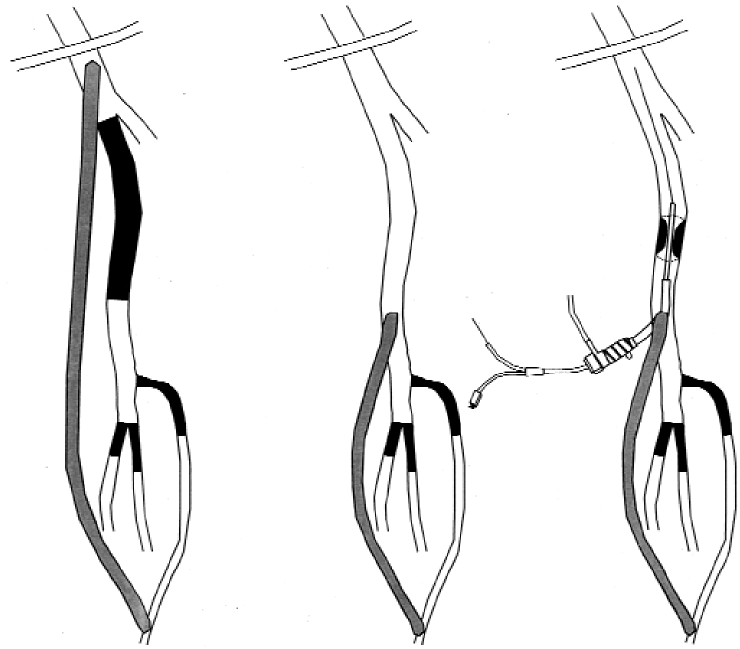

Fig 1. Tibial and pedal bypass grafts among 110 diabetic patients with gangrene were performed with three different approaches according to pattern of occlusive disease. Long bypass grafts (n = 46) originated from femoral artery in the groin; short bypass grafts (n = 52) originated from popliteal artery. In the combined group (n = 12), IBA of focal SFA lesion was followed by distal bypass graft originating from popliteal artery.

is a reasonable option for limb salvage revascularization in selected diabetic patients with gangrene.

METHODS

Patients. Over a 6-year period (August 1, 1994, to July 31, 2000) at a single community hospital, 380 infrainguinal bypass grafts were performed. Among these patients, there were 110 diabetics with lower extremity gangrene who underwent reversed saphenous vein bypass grafts to the tibial or pedal vessels for limb salvage and who form the basis of this report. Patients with rest pain or superficial, nonhealing ulcers were excluded because many of these patients were treated without performing tibial or pedal bypass grafts. Patients without diabetes and patients who underwent revascularization procedures other than infrapopliteal bypass grafts were also excluded because these patients did not have tibial disease that required bypass graft. Data collected included atherosclerotic risk factors, patient demographics, hemodynamic assessment, operative details, and follow-up data, both clinical and noninvasive. Outcomes included primary and secondary patency, limb salvage, and survival.

Patient evaluation included clinical assessment, noninvasive testing, and arteriography. Local wound care, antibiotics, debridement, and minor amputation were used to control infection. The damaged extremity was protected by means of the patient resting in bed, walking on crutches, or having contact casting to avoid further trauma. Limbs rendered unsalvageable because of extensive damage to vital structures or uncontrollable infection were not subjected to infrainguinal bypass graft. Long-term nonambulatory patients and those with medical risk that prohibited surgery were not considered candidates for operation.

Revascularization procedures. Aortoiliac inflow occlusive disease was treated before or simultaneous with infrainguinal bypass graft surgery. Infrainguinal bypass grafts were performed with reversed saphenous vein. The extent of the bypass graft, proximal to distal, was determined by the pattern of occlusive disease (Fig 1). Extensive infrainguinal occlusive disease involving both the femoral-popliteal segment and the infrageniculate arteries was treated with an infrainguinal bypass graft originating from the femoral artery in the groin and extending the length of the limb to a target site in the tibial or pedal vessels (long bypass graft group, n = 46). These bypass grafts originated from the common femoral artery (38), the profunda femoris (3), or the very proximal SFA (5). SFA occlusive disease was considered too extensive for balloon angioplasty when there was more than one lesion causing > 50% stenosis or a single lesion that was more than 3 cm in length. Those with severe infrageniculate occlusive disease but with patent and well-preserved femoral-popliteal vessels (0% to 49% stenosis throughout) underwent bypass graft from the popliteal artery to the tibial or pedal vessels (short bypass graft group, n = 52). Patients who required popliteal-distal bypass graft but who also had a focal SFA lesion were treated with combined, simultaneous, popliteal-distal bypass graft and IBA

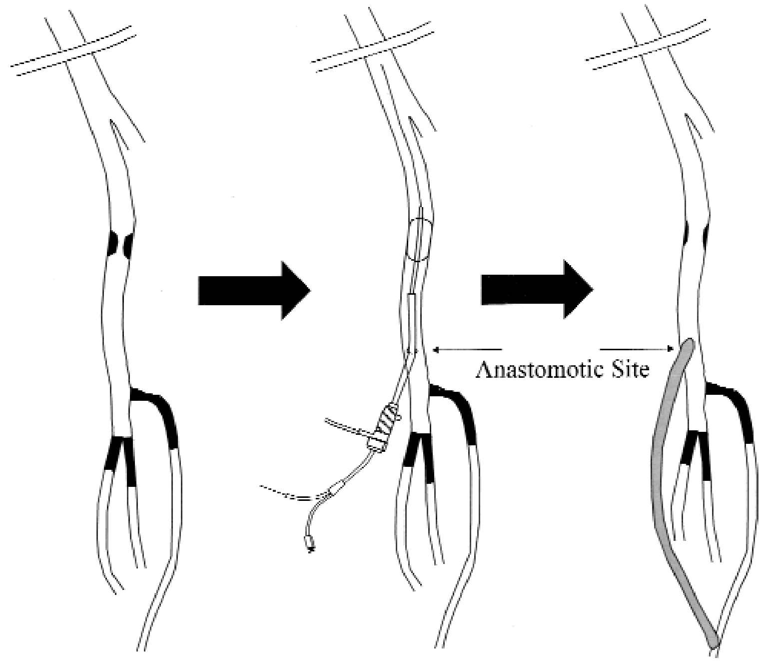

Fig 2. Schematic of combined procedure. Patients selected included only those with focal SFA inflow lesions and severe infrageniculate occlusive disease requiring bypass graft. Guidewire and sheath are inserted retrograde into popliteal artery at site intended for proximal anastomosis for bypass graft. After IBA, popliteal origin bypass graft is performed.

of the inflow SFA (combined group, n = 12). Lesions intended for treatment with IBA were identified preoperatively with arteriography and included only single focal stenoses less than 3 cm in length (Category 1).[9] Among the bypass grafts of popliteal origin performed, 55 were from the below-knee popliteal artery, and nine were from the above-knee popliteal artery.

IBA was performed after vein harvest, arterial access, tunneling, and heparin administration for the popliteal-distal bypass graft.[10] The popliteal artery, which would serve as the site of proximal anastomosis, was punctured with an angiographic entry needle, and a 0.035-in diameter floppy-tipped guidewire was advanced retrograde under fluoroscopy into the SFA (Fig 2). Retraction of the artery caudally with a Silastic loop (Dow Corning Corp, Midland, Mich) simplified this maneuver and helped ensure that only a single-wall puncture was performed. A 5F angiographic access sheath was advanced over the guidewire. Retrograde femoral arteriography was performed through the sidearm of the sheath with a portable, digital subtraction technique. Arteriographic images were enhanced with the placement of the image intensifier close to the surface of the area of interest and with beam filters. Contrast usage was minimized by aspirating the contrast from the femoral-popliteal segment after the images were obtained. The guidewire was advanced through the SFA lesion by means of fluoroscopy. A 6-mm balloon angioplasty catheter was advanced over the guidewire, through the sheath and into the lesion. The balloon was brought to full profile with fluoroscopic visualization. Completion arteriography was performed through the sidearm of the sheath. Contrast required for the procedure ranged from 15 to 40 mL. When completion arteriography demonstrated a significant residual lesion or flow-limiting dissection, the 5F sheath was exchanged for a 7F sheath and a flexible, self-expanding stent was placed at the angioplasty site (Wallstent; Meditech, Watertown, Mass). Pressure gradients were not useful in this setting because outflow occlusion was present in each case because of tibial occlusive disease. Any residual stenosis > 30% was treated with stent placement. Oblique projections of the angioplasty site were obtained when the severity of a residual lesion required further assessment. Stents were placed in five patients (42%). After a satisfactory completion arteriogram was obtained, the guidewire and sheath were removed and the popliteal artery was clamped. The arteriotomy was extended, and the proximal anastomosis was performed.

Follow-up. Surveillance duplex scans were performed at 1 month, at 6 months, at 12 months, annually, and as needed, according to any changes in the clinical examination or ankle/brachial indices. Arteriography was indicated when there was a duplex scan with abnormal findings (velocity ratio > 2.0).

Statistical analysis. Risk factors and demographic variables were compared among treatment groups with either one-way analysis of variables or the χ^2 test. Primary patency, secondary patency, limb salvage, and patient survival were estimated with the Kaplan-Meier method.[11]

Table I. Study characteristics stratified by operative group

Factor	*Combined (N = 12)*	*Short (N = 52)*	*Long (N = 46)*	P *value**
Age (y) (mean ± SD)	70 ± 13	69 ± 11	68 ± 11	.9
Sex (male)	83%	65%	50%	.07
Smoker	33%	20%	36%	.2
Coronary artery disease	33%	49%	38%	.4
Hypertension	17%	16%	24%	.6
Renal failure	58%	67%	74%	.5
Prior inflow procedure	0%	4%	11%	.2
Prior contralateral procedure	33%	21%	26%	.6
Location of gangrene				.1
Toe	0%	33%	37%	
Forefoot	83%	54%	46%	
Hindfoot	17%	13%	17%	
Target vessel				.04
Tibial	25%	35%	57%	
Pedal	75%	65%	43%	
Preoperative ABI (mean ± SD)	0.52 ± 0.19	0.46 ± 0.15	0.42 ± 0.17	.3
Warfarin sodium (Coumadin)	17%	4%	15%	.2

**P* values were calculated with one-way analysis of variance for continuous variables and χ^2 tests for categorical variables.
ABI, Ankle/brachial index.

Treatment groups were compared with respect to these outcome measures by means of the log-rank test. Cox regression analysis was used to compute adjusted and non-adjusted hazard ratios to evaluate the relative risk of graft failure or limb loss in the combined group compared with the other treatment groups.

RESULTS

Patient population. Among 110 diabetic patients with lower extremity gangrene treated in this study, there were 67 men and 43 women, and the mean age was 69 years (range, 43-88). Atherosclerotic risk factors included hypertension in 80%, previous or current cigarette smoking in 27%, coronary artery disease in 55%, and renal failure requiring long-term dialysis in 31%. Gangrene was localized to one or more toes in 31%, to the forefoot in 54%, and to the heel in 15%. Previous or simultaneous inflow procedures were required in seven patients (6%) including aortofemoral bypass graft (1), axillofemoral bypass graft (2), and iliac balloon angioplasty (4). Contralateral limb ischemia subsequently occurred in 27 patients (25%), which required either revascularization (23) or amputation (4). The combined treatment group was compared with both the short and long groups with respect to these factors, and there were no significant differences (Table I).

Treatment. Reversed saphenous vein bypass graft was performed in each case. Target sites included the anterior tibial artery (16), the peroneal artery (21), the posterior tibial artery (30), the dorsalis pedis artery (30), and the plantar arteries (13). There were 63 bypass grafts (67%) to the ankle or foot and 47 bypass grafts to the tibial arteries. More bypass grafts to the ankle and foot were performed in the combined group than in the other treatment groups (*P* = .04). Anticoagulation was used postoperatively in 11 patients (10%). The use of anticoagulation was similar among the groups and did not affect outcome. There was no perioperative graft failure or limb loss. There was one perioperative death (1%) due to acute myocardial infarction (1 of 110).

During follow-up, there were 21 graft failures (19%) at a mean of 18 months due to either occlusion (12) or stenosis that was detected with duplex scan surveillance (9). There were 8 graft failures in the long group, 10 in the short group, and 3 in the combined group. Graft revision was performed in 11 patients. In the combined group, two SFA angioplasty sites developed recurrent stenosis at 7 and 48 months; both were detected with duplex scan surveillance and treated with PTA. Another patient in the combined group had stenosis in the distal vein graft, which was repaired at 12 months. Overall, there were nine leg amputations (8%), at a mean of 22 months. Among these, two were performed in patients with patent bypass grafts but with persistent infection, and seven were associated with bypass graft occlusion.

Outcome. Mean follow-up was 23 months. Primary patency for all 110 tibial and pedal bypass grafts was 78% ± 5% at 2 years and 63% ± 8% at 5 years. There was no significant difference in primary patency among the treatment groups (*P* = .8, Fig 3). The 2-year primary patency was 72% ± 10% in the long group, 82% ± 6% in the short group, and 76% ± 14% in the combined group. Primary patency was also compared among the treatment groups with Cox regression analysis: there was no greater likelihood of graft failure in the combined group than in the long group or the short group (Table II).

Secondary patency was 89% ± 4% at 2 years and 78% ± 7% at 5 years. The 2-year secondary patencies were not significantly different among the treatment groups: 86% ± 8% in the long group, 90% ± 5% in the short group, and 100% in the combined group (*P* = .3, Fig 4).

Limb salvage was 89% ± 4% and 81% ± 6% at 2 and 5 years, respectively. There were no significant differences in

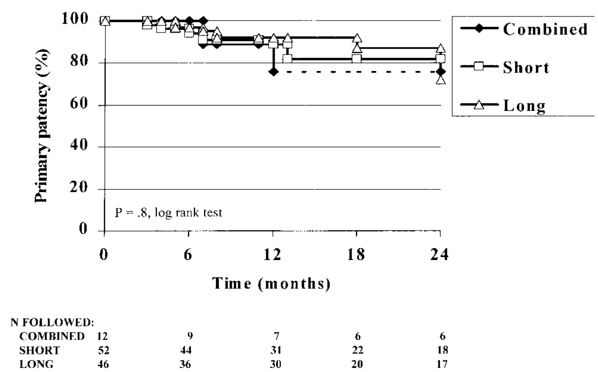

Fig 3. Primary patency in long (n = 46), short (n = 52), and combined (n = 12) groups with life-table format. There was no significant difference among treatment groups (P = .8 by log-rank test). *Dashed line* indicates SE exceeds 10%.

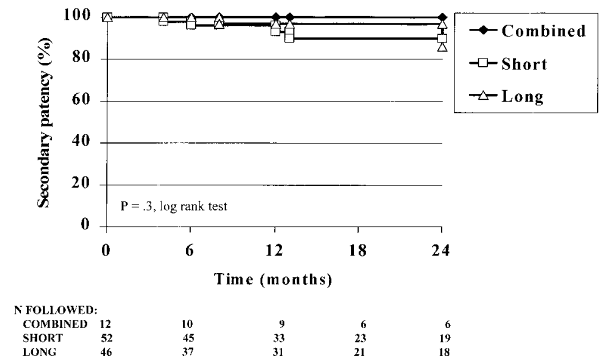

Fig 4. Secondary patency in long, short, and combined groups with life-table format. There was no significant difference among groups (P = .3 by log-rank test).

Table II. Cox regression analysis of association of study outcomes with operative group

	Unadjusted		*Adjusted**	
Comparison	*Hazard ratio (95% CI)*†	P *value*	*Hazard ratio (95% CI)*†	P *value*
Primary patency				
Short bypass graft	1.3 (0.4-4.9)	.7	1.3 (0.3-5.4)	.8
Long bypass graft	1.6 (0.4-6.2)	.5	1.2 (0.2-6.2)	.9
Limb salvage				
Short bypass graft	1.4 (0.1-13.4)	.8	1.3 (0.1-16.6)	.9
Long bypass graft	0.7 (0.1-6.1)	.7	0.5 (0.0-7.3)	.6

*Adjusted for age, sex, cigarette smoking, coronary artery disease, hypertension, hyperlipidemia, renal failure, prior inflow procedure, target vessel, and warfarin sodium (Coumadin) use. In addition, limb salvage estimates were adjusted for location of gangrene.
†Ratio of graft failure or limb loss for the "Combined" group relative to the group listed.

limb salvage in the three treatment groups with life-table analysis: at 2 years it was 78% ± 9% in the long group, 98% ± 2% in the short group, and 90% ± 9% in the combined group (P = .6, Fig 5). Limb salvage was compared among the three treatment groups with Cox regression analysis, and there was no significant difference with both adjusted and unadjusted data (Table II). Overall survival was 77% ± 6% at 2 years and 35% ± 8% at 5 years, and there was no significant difference among the treatment groups (P = .9).

DISCUSSION

The salvage of ischemic, gangrenous lower extremities in diabetic patients depends on the restoration of distal perfusion by whatever means are available. Autogenous vein bypass graft is usually required from either the femoral or the popliteal artery to a distal outflow site. The reported 5-year patency rates for autogenous vein bypass grafts to the tibial and pedal arteries range from 63% to 69%, and secondary patency rates range from 72% to 85%.[12-15] The results of the current series are comparable: among 110 patients with infrapopliteal bypass grafts, the 5-year primary patency was 63%, and the secondary patency was 78%. Limb salvage at 5 years for the entire group was 81%; this rate is similar to published results of 80% to 90%.[12-15] The 5-year, 35% overall survival reflects the severe medical illnesses in this group and is similar to other studies in which survival of 28% to 66% has been documented.[12-15]

The combination of intraoperative SFA balloon angioplasty and distal bypass graft originating from the popliteal artery provides an alternative to long, lower-extremity bypass graft in diabetic patients with focal SFA stenosis proximal to severe infrageniculate occlusive disease. Outcomes for the combined approach were compared with those resulting from the long bypass graft (originating from the femoral artery) and the short bypass graft (from the popliteal artery). Many of the complex variables that make it difficult to assess revascularization options were excluded; all of the study patients were diabetics with gangrene who underwent reversed saphenous vein bypass grafts to the infrapopliteal vessels for limb salvage. Although the combined group included more bypass grafts to the ankle and foot, the treatment groups were otherwise similar with respect to other demographic and risk factors. There was no significant difference in graft patency or limb salvage between the combined group and the more traditional long bypass graft group. Among the

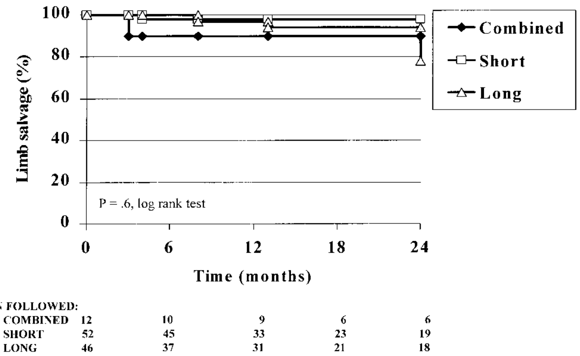

Fig 5. Limb salvage in long, short, and combined groups with life-table format. There was no significant difference among groups (P = .6 by log-rank test).

patients who underwent popliteal to distal bypass graft, there was no significant difference in outcome whether IBA of the SFA was performed for inflow.

There are several potential advantages of this approach. The SFA angioplasty permits a shorter bypass graft to be performed when ipsilateral vein length is inadequate. In this study population, saphenous vein length was at a premium because 25% of the patients required contralateral limb revascularization, 55% had documented coronary artery disease, and dialysis dependency was present in 31%, often making upper extremity veins unavailable for use as lower extremity conduit. When pedal bypass graft is required in patients with high medical risk, the combined technique provides an opportunity to decrease the magnitude of the open surgical procedure with the use of endovascular intervention. Performing a shorter bypass graft avoids distal vein harvesting and the parallel incisions at the ankle or foot that are often required for femoral-pedal bypass graft. The poor long-term survival in this patient population (35% at 5 years) suggests that revascularization options that are successful for the short and intermediate time frame are often adequate to meet the patients' needs. If recurrent stenosis at the angioplasty site occurs at a later time, it may be treated electively, after gangrene has healed, with either PTA or above-knee femoral-popliteal bypass graft.

Although the current study demonstrated that combining endovascular and open techniques was useful in a subgroup of diabetic patients with gangrene, this technique is not applicable in many settings. Using SFA balloon angioplasty as inflow for a distal bypass graft depends on the availability and accuracy of duplex scan surveillance. In programs where endovascular skills and equipment are not readily available, a long bypass graft is probably simpler and safer. The combined group was too small to make conclusions about long-term patency. Among patients with a reasonable likelihood of surviving 5 years or more, this approach should only be undertaken with the understanding that long-term results are not known and that duplex scan surveillance would be required.

A major disadvantage of combining SFA angioplasty with popliteal origin bypass graft is that each IBA site represents an additional location along the flow stream where failure may occur. The results of SFA balloon angioplasty vary widely; success rates range from 47% to 86% at 1 year and from 38% to 58% at 5 years.[16-19] However, when focal lesions alone were treated, patency rates were substantially better. Jeans et al[20] showed a 76% patency at 5 years for PTA of SFA stenoses < 1 cm in length versus 50% patency for longer lesions. Krepel at al[21] demonstrated 5-year patencies of 77% for lesions < 2 cm in length and 54% for lesions > 2 cm. In the current series, only focal lesions were considered for treatment with IBA.

Other factors that influence the results of SFA balloon angioplasty are the use of stents, the quality of distal runoff, the indication for the procedure, and the presence of diabetes. Stents have not been shown to provide any significant benefit to the long-term patency of SFA PTA.[22-24] Stents should be used selectively, as they were in this study, for extensive dissection or residual stenosis that threatens the immediate patency of SFA balloon angioplasty.[25,26] With the decrease of the incidence of immediate technical failure, stents have made IBA of the SFA a safer procedure, helping to guarantee the integrity of the inflow for the popliteal origin bypass graft. Five of the 12 patients who underwent SFA IBA received stents, and there were no early angioplasty failures.

The indication for revascularization and the quality of the runoff are two factors that are intricately associated whenever balloon angioplasty results are considered. The anatomic hallmark of most limb salvage cases is multilevel occlusive disease with poor distal runoff, which cannot be adequately managed with PTA. As a result, SFA PTA in limb salvage has not been particularly effective as a sole revascularization procedure.[8,20] The results of SFA PTA have been consistently better when runoff was adequate.[16-19,21] In the case of SFA IBA and combined distal bypass graft, balloon angioplasty is required to manage only one level of focal, proximal infrainguinal disease, whereas runoff is enhanced by the construction of a distal bypass graft. Improved outflow may enhance the long-term patency of SFA balloon angioplasty. Thus, SFA balloon angioplasty for limb salvage is likely to be more successful in combination with distal bypass graft than as a sole revascularization procedure.

It has long been recognized that diabetic patients tend to have relatively well-preserved femoral vasculature, but much more severe tibial and pedal occlusive disease than patients without diabetes.[27,28] Although diabetes appears to be a risk factor for failure after SFA PTA in some studies, when risk was adjusted for the distribution of lesions and the quality of runoff, there was no significant difference between patients with and without diabetes.[19,29-32] The success of balloon angioplasty is primarily determined by the pattern of occlusive disease, rather than the presence of diabetes or other factors.

The incorporation of endovascular techniques into open vascular operations has become a routine practice.

Factors that contributed to this development include the availability of quality intraoperative fluoroscopic imaging, the procurement of an inventory of endovascular supplies in the operating room, the development of stent-grafts, and the refinement of endovascular skills. Although indications are limited, the use of SFA IBA could be readily adopted into vascular programs that have already mastered other combined procedures.

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DISCUSSION

Dr. E. John Harris, Jr (Stanford, Calif). Treatment of ischemic limbs in patients with diabetes is a difficult problem often requiring multiple tedious bypass procedures to effect limb salvage. Many occasional vascular surgeons avoid these procedures altogether and suggest primary amputation, which may often be a reasonable recommendation. Those of us with an established interest in limb salvage surgery often thrive on the challenge of limb salvage in these difficult patients and will routinely consider distal tibial and pedal bypass with composite autogenous vein grafts as a suitable solution. When confronted with little suitable autogenous vein, one often considers more distal origins for the graft, but in these patients, the SFA is often diseased above a potential popliteal origin. Dr Schneider and his group bring to us today a concept for treatment of ischemic diabetic limbs in patients with focal superficial femoral artery disease and distal tibial or pedal targets for bypass. In most of our practices, such a patient would receive a long autogenous bypass from a proximal femoral artery inflow source to the distal tibial or pedal target. In this series, the majority of patients did have a long bypass when the popliteal artery was not a suitable inflow source or a popliteal to pedal or tibial bypass when there was no significant SFA disease, and only 12 patients had adjunctive SFA angioplasty with a popliteal to tibial or pedal bypass.

The criterion for SFA angioplasty was a focal stenosis < 2 cm in length, with the procedure performed retrograde from a surgically exposed popliteal artery. Technical success was excellent, there were no failures, and the durability of this procedure was not significantly different from the other distal bypass groups described. I note that two of the three failed grafts in the combined angioplasty-popliteal-distal bypass group occurred in the SFA angioplasty site, yet only 42% of the SFA angioplasties were treated with adjunctive Wallstents. In retrospect, would these failures have been prevented by a procedure that employs stents in all angioplasty sites rather than selective use as you describe? Were there any failures in stented angioplasty sites?

Limb salvage was similar in all three groups (81% at 5 years) and quite good for such a difficult group of patients. Only two of the nine amputations were performed in patients with patent bypass grafts. This is different from my own experience where I find that open pedal wounds, especially on the calcaneus with a graft to the anterior tibial or dorsal pedal artery, often fail to heal in spite of a patent graft. What were your results in the 16 heel wounds? Did they all heal after bypass?

This was a typical diabetic patient population, with limb salvage as the main indication for intervention, yet there was a surprisingly low incidence of tobacco abuse. With only 30% of the population smoking, why is there such a severe 5-year mortality rate of 35% in your patients?

I commend Dr Schneider for this careful recommendation of combined SFA angioplasty above a popliteal to tibial or pedal bypass. His results are excellent, and they reflect his conservative and well–thought-out use of this procedure. The manuscript is informative and well written, and I recommend it to you all once it is published.

Dr Peter A. Schneider. The first question that Dr Harris asked is whether or not all superficial femoral artery lesions should be stented. The reason we stented them selectively and probably will continue to do so is that there have been two randomized trials that showed no difference in the 1-year patency of stented and nonstented lesions.

The key benefit of stenting is that it is a procedure that can very reliably be performed with immediate success. It's perfect for the operating room. With a stent you're going to get a beautiful result with close to 100% certainty and that makes it something that you can reliably base inflow for a distal bypass graft on.

The second question was about the patients with the heel wounds. This is a very difficult group. One of the things that helped a lot is that we do have in our institution a diabetic limb treatment program that mandates a referral for every diabetic with a foot wound, whether they have pulses or not. They are referred to our diabetic limb treatment program. We have a nurse coordinator, an infectious disease doctor, vascular surgeons, two podiatrists, and an orthopedist. We have clinic once a week.

It's almost impossible for people to circulate for too long with a foot problem because the referral is essentially mandated. A lot of these lesions that I might have seen later I'm seeing sooner, and I'm having an opportunity before the foot damage is so severe that they can't be fixed. This is the way to save feet with heel lesions.

The last question was about the mortality in this group. I think it's because there were a lot of patients with renal failure. When we looked at our renal failure population, the mortality in that group was really quite high.

Dr Sam Ahn (Los Angeles, Calif). Dr Schneider, those are excellent results. I would like to offer an alternative to your technique. For patients with wet, gross gangrene, certainly you need to treat both the SFA and tibial disease at the same time. But for patients with *dry* gangrene with fairy small areas of necrosis or gangrene or chronically nonhealing ulcers, I propose performing just the balloon angioplasty of the SFA lesion, then waiting and seeing what happens. In my experience about half of those patients will heal without doing the distal popliteal tibial bypass. Would you consider that as another option?

Dr Schneider. That's an excellent point, and, in fact, one of the things that we're looking at currently in my institution is the use of angioplasty as the sole method of limb revascularization. I think there is a small subset of patients that fit the category of exactly what you're talking about.

The hard question is when someone shows up in your office, how do you know which is which, how much revascularization is enough, and that's sort of a basic question that we always have to go through.

Dr Ronald Dalman (Stanford, Calif). Peter, I think this makes a lot of sense for a patient who has a relatively short segment of suitable vein available. I'm just curious, based on your experience, what's your preference if a patient needs a distal bypass but has a suitable length of autogenous vein for a traditional proximal anastomosis at the common superficial/superficial femoral?

Just as a comparison, one of our colleagues in the San Jose area who does this seems to do this preferentially now to a longer bypass. He's taken to angioplasty most SFA lesions and basing bypasses distal to that even when suitable vein is available for longer bypass. I'm just curious what your preferences are based on your experience.

Dr Schneider. If I have a patient who I think is going to be around for more than 5 years, I would probably do a long bypass.

Dr Raker. I have two questions. One is, how did you assess how well your SFA balloon angioplasty was? Did you do pressures afterwards looking for other occult lesions in the SFA that might not be seen by imaging?

Then the second question is, did you exclude neuropathic patients from your series, and if not, why don't we see more neuropathic ulcers in the revascularized patients postoperatively?

Dr Schneider. All of the patients in the series are patients who had critical ischemia with accompanying gangrene. Some of them had neuropathy, but I think in general, it was a very ischemic group. They had low toe pressures and low ABIs.

We did not measure pressures. We did do, though, early postoperative duplex scanning. So we looked at our velocities through the angioplasty site, and when the patients came back for their surveillance of their distal bypass grafts, they also had surveillance at the angioplasty site itself. That was how we picked up two recurrent stenoses that subsequently underwent repeat angioplasty.